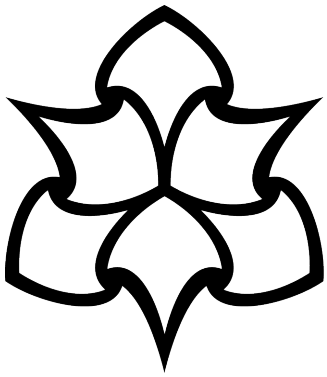

Industrialised Building Systems (IBS) – A Strategic Outlook of Manufactured Construction in Malaysia

Lou, E.C.W.[1] & Kamar, K.A.M.[2]

Forum paper

Keywords

Construction, Industrialized Building Systems, Manufactured construction, Malaysia.

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[1] Research Manager, School of Built Environment, University of Salford, UK.

[2] Manager, Technology Transfer Division, Construction Research Institute Malaysia (CREAM), Kuala Lumpur, Malaysia.

Background

The Malaysian Construction Industry (CI) orchestrates an essential role in generating wealth for the nation and facilitate the development of social and economic well-being of the country. The industry employs an estimated 800,000 people, which represented 8% of total workforce (CIDB, 2006). This industry grew at 5.3% at 2007 and contributes 2.1% of total GDP for Malaysia (CIDB, 2008) – creating a multiplier effect for other industries to expand and develop (including manufacturing sector, financial and banking, agriculture, mining and professional services). The estimated construction demand under the 9th Malaysia Plan spanning from 2006-2010 is in the region of RM280billion (£56 billion*), an average of RM56 billion per year in the stipulated timeframe (EPU, 2006). Further analysis shows RM120 billion demand will come from public spending, RM140 billion contributed by the private sectors and another RM20 billion under the Private Finance Initiatives (PFI) (CIDB, 2007).

However, the industry is under a constant pressure to improve its performance. According to Construction Industry Development Board (CIDB) Malaysia, 69% (552,000) out of total 800,000 of registered workers as in June 2007 were foreign workers (CIDB, 2007). Foreign workers are usually associated to unskilled workers, and thus provided a negative impact on the productivity and quality of the industry. Social problems associated with foreign workers have further aggravates the situation. The self-aggravated 3-D syndrome – dirty, difficult, and dangerous – distanced the local workforce and new graduates to participate in the industry. The productivity level of the industry experienced 1.52% increase from the previous year, but the level of growth is relatively low compared to other industries in the country (MPC, 2009). Occupational accidents and death rate in the industry is one of the highest in the country, accumulating to a total of 72 reported cases in 2008 and 95 reported cases in 2007. These rates were on-par with the number of cases as in manufacturing industry, although manufacturing account for larger volume of works and higher number of occupational accidents (DOSH, 2008). Issues of sustainability have been duly highlighted in the Construction Industry Master Plan (CIMP) (CIDB, 2006) as being of significant importance for the Malaysian CI. The Malaysian Green Building Index (GBI) has been developed recently to promote sustainability construction in built

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* *Exchange rate approximately £1 = RM5 (27 Nov 2010)*

environment. The introduction of this rating system has provides a new challenges for the industry players particularly in building construction.

Conventional construction is a common practice in Malaysia – it consists of reinforced concrete frame and brick, beam, column, wall and roof, which are cast in-situ using timber framework; while steel reinforcement is fabricated off-site. This method is labour intensive involving formwork fabrication, steel bending and concreting. It requires many wet trades on site such as skill carpenters, plasterers and brick workers. This process can hamper by quality issue, unfavourable site condition, skilled labour shortage and bad weather conditions.

However, the move towards industrialisation of construction industry is a global phenomenon and not merely a local or isolated initiative. There is a myriad of definition and classification – Off-site Construction (OSC), Modern Method of Construction (MMC), Off-site Manufacturing (OSM), Off-site Production (OSP), preassembly and prefabrication – are worth to be examined. The term and classification were often misinterpreted as a system limited only for construction of buildings. It can be defined as an approach or process used in making construction less labour-oriented and faster as well as fulfilling quality concern (Shaari and Ismail, 2003). The broader view of IBS is about the changing of conventional mindset, championing human capital development, developing better cooperation and trust, promoting transparency and integrity (ibid). The term was invented to shift from the typical paradigm of prefabricated systems.

In Finland, offsite manufacturing represented 70% of total building construction. It offers effective and rapid site assembly and improving the quality and productivity of construction (Sarja, 1998). The Japanese house building industry has been developed the most advance manufacturing techniques in construction – led by the automation and robotic applied in both manufacturing floor and onsite construction for better quality, minimum onsite duration and better value for customer (Gibb, 2001). Offsite manufacturing in Germany improved quality of their housing industry and provided a better value with considerable variety and flexibility in design. It also helped the developers to overcome strict standard of quality control imposed by local authorities (DTI, 2009).

To cope with current and future challenges, the CIMP was published as means to chart the future direction of the Malaysian construction industry (CIDB, 2006). The CIMP presents a strategic roadmap

for Malaysia's construction industry to develop into a sector that is able not only to meet the challenges of international competition and seize the opportunities afforded in the global marketplace, but also to make a significant contribution to the nation's aspirations and increase the welfare of its people. Outlined within the CIMP are the vision, mission, eight critical success factors, seven strategic thrusts (Table 1), and 21 specific recommendations that will guide the development of the Malaysian CI.

In response to the CIMP, championed by CIDB, the industry has been urged to use innovative new construction techniques, methods and technologies, to shift from traditional practices to Industrialised Building System (IBS) construction. This action is further championed by CIDB Malaysia. The importance of IBS was highlighted under the *Strategic Thrust 5: Innovate through R&D to adopt a new construction method* in the CIMP.

Industrialised Building System (IBS) in Malaysia

Industrialised Building System (IBS) is the term to represent the prefabrication concept in Malaysia; and has been widely used as a common understanding by practitioners and researchers in Malaysia (CIDB, 2003; Hamid *et al*., 2008; Kamar *et al*., 2009). IBS is defined as a construction technique in which components are manufactured in a controlled environment (on or off site), transported, positioned and assembled into a structure with minimal additional site work (CIDB, 2003). IBS offers benefits to adopters in term of cost and time certainty, attaining better construction quality and productivity, reducing risk related to occupational safety and health, alleviating issue on skilled workers and dependency on manual foreign labour and achieving ultimate goal of reducing overall cost of construction.

The government has taken lead in the implementation of IBS in the industry. Back in 2004, the government announced that all new government initiated building projects were required then to have at least 50% of IBS content, calculated using 'IBS Score Manual' developed by CIDB. In the Malaysian 2005 Budget, the government had pledged to construct 100,000 units of affordable houses using the IBS concept. Currently, all the government imposes a construction levy of 0.125% of the total project cost (according to the Constitution Article 520), which is collected through CIDB. The government now is exempting this levy to contractors who incorporates IBS in at least 50% of building

components, commencing first January 2007. A new Treasury circular (Surat Pekeliling Perbendaharaan Bil. 7 Tahun 2008) dated on October 2008 had emphasized the full utilization of IBS in government's projects. Among the pressing matters raised in the circular were the use of IBS component in government projects must not be less than 70% and the inclusion of IBS as part of contract documents for all government's building works. As on February 2009, a total of 320 government's projects worth RM9.43 billion were carried out using IBS (Bernama, 2009). Looking ahead to further promote the use of IBS, the government will introduce a new policy to reduce 50% of the current 320,000 foreign workers registered with the industry. CIDB has allocated RM100 million to train domestic skilled and unskilled workers, targeted on IBS-related construction and other specialist trades (Bernama, 2009).

However, all is not as rosy as it seems. The industry suffers from the abundant availability of unskilled and cheap workers from neighbouring countries over the years, and this has sustained traditional and conventional building practice – making IBS very unpopular. There is no viable short-term or strategic long-term incentive for private contractors to change their current practices. To address this problem further, CIDB has conducted three major surveys into the implementation of IBS in the Malaysian CI.

- IBS Survey 2003 stated that only 15 % of total construction projects used IBS in Malaysia in 2003 (CIDB, 2003a);
- IBS Survey 2005 focused on architects and designer's views, conveyed that the majority of the architects claimed to have poor knowledge of IBS; resulting in the low uptake on IBS (CIDB, 2005);
- IBS Mid Term Review (2007), it is reported that only 10% of the completed projects used IBS in 2006; less than 35% of total construction projects used at least one IBS product - compared to forecast of completed IBS projects of 50 % in 2006 and 70% in year 2008, as estimated by the IBS Roadmap (Hamid *et al*., 2008).

There is a myriad of issues that are discouraging the use of IBS in Malaysia. In 2006, IBS Steering Committee highlighted the shortcomings on IBS implementation as poor roadmap implementation, the high cost of IBS components, low standardisation of components and design solutions, poor human capital development on IBS, the unavailability of centralised R&D Centre for IBS, lack of specialised

resource centre for IBS, unavailability of certification and accreditation scheme on IBS, and there are initiatives by too many parties as coordinator. Through the IBS Roadmap Mid Term Reviews 2007, the reported issues of the lack of integration in the design stage, poor IBS knowledge in the industry, lack of support and understanding from construction professionals, and common misunderstanding and misinterpretation of building regulations caused by the usage of IBS. Again in 2007, the Construction Research Institute of Malaysia (CREAM) has conducted a workshop with the captains of the industry and sited the barriers to a greater IBS adoption – the first being IBS is not popular among design consultants; lack of knowledge among designers; the need for mindset change; chicken and egg dilemma; lack of support and slow adoption from private sector; lack of push factor from responsible bodies; volume and economy of production in scale to IBS components; monopoly of big boys, limiting opportunities to other contractors; low IBS construction components available in the market; IBS require onsite specialised skills for assembly of components; lack of special equipments and machineries; lack of local R&D on technologies and testing facilities; mismatch between readiness of industry with IBS targets; insufficient capacity for contractors to secure project; and sustainability issue, government to lead during downturn.

IBS implementation issues

To further aggravate the interest in IBS in the Malaysian CI, the Construction Industry Development Board (CIDB) Malaysia, Construction Research Institute of Malaysia (CREAM), University Technology MARA Malaysia (UiTM) and University of Salford (UK) conducted a joint workshop entitled 'Industrialised Building System (IBS): Implementation Strategy from R&D Perspective' in November 2009. Workshop attendees were carefully selected from various government agencies, professional bodies and from construction practitioners. The workshop results and recommendations are being used as a proposed guidance and reference for policy makers and IBS promoters to path the way forward in establishing new policies on IBS, guiding the promotion activities and identifying the potential themes and titles for future research and development in IBS. The report was submitted to the CIDB Executive and IBS Centre for the formulation of implementation strategy. The main task was to identify the problems on the implementation of IBS from the perspective of manufacturers, contractors

and suppliers. The attendees agreed that the low rate of adoption is mainly contributed to the poor understanding on IBS by professional and designers in the industry – the fragmented industry does not help either. There is also strong resistance from conventional contractors to change their existing ways, and the difficulty to meet the design and manufacturing requirements. The contractors often moan about the lack of incentives in implementing IBS for the short and long term – private organisations will require quick-wins to convince top management and operational staff; and to incorporate organisational IBS strategy in the long term. The cost of changing from conventional design and IBS designs costs more, but is not compensated throughout the lifecycle of the project. The lack of standard designs stops IBS design from the grass root level. Architects are not able to include IBS and component design into drawings, hence, not adopted. In addition, the unsuitable skilled and unskilled labours, and unavailability of training makes implementation difficult. It is also intricate for the industry to attract new workers to join the workforce and re-train them with new IBS skills. From the manufacturer's perspective, there are simply not enough of active IBS component manufacturers in Malaysia. The small volume of demand does not provide the economics of scale – high capital expenditure to produce the project, but low income (Khalfan *et al*., 2008). There is also no standard design and nor guidelines for the product. Similarly, there are no expert workers in this area and expert training is limited or simply not available. At this moment, the poor IBS demand and the lack of interest from the industry is affecting the suppliers and their willingness to embrace in IBS market. There are major difficulties for the supplier to cope with the (product specification) demand of manufacturing and the design of construction. A summary IBS implementation barriers by the industry and adopters, and their low and high impact is as shown in Figure 1.

Following the first Workshop, second edition of IBS Roundtable Workshop (IRW02) was held in November 2009 supported and sponsored by Technology and Innovation Development Sector (SPTI) and the Construction Industry Development Board (CIDB). A set of critical success factors (CSFs) was concluded during the workshop. The CSF approach became well established under the work of Bullen and Rockhart (1981) and Rockhart and Crescenzi (1984). Construction businesses exist today for one reason – to make money – in order to have optimum business returns, business strategies are essential for success. A top-down corporate vision and direction must be clear; IBS must be understood by all

level of decision makers, as well as the maturity of the company. Embracing IBS requires strategy in business, and strategy is important in assessing the viability of the project. The internal capability of the organisation must be evaluated to ensure the organization is capable and ready to uptake IBS. Employee skills and competency should be evaluated in both soft and hard skills to undertake IBS in every stage of construction. New organisations should acquiring knowledge or have joint-venture projects with established adopters to ensure success. Information Technology (IT) is seen as the enabling factor to support tools for IBS implementation – IBS enabled CAD software is essential to encapsulate the various existing IBS products, and incorporating supply chain management into the construction processes. An integrated IT system that could combine construction design, planning and monitoring is essential. The adoption of IBS also requires good capital investment for the production of the product (factory setting). In the context of partnering and contract, adopters want to be able to work together with clients, manufacturers and designers from the beginning to the delivery. To accelerate change and expedite learning curve, adopters need to partner with established organisations with sufficient technical know-how. A strategic alliance with other companies is important to secure contract in public and private projects. In reality, there is poor project partnering in construction projects, as well as in supply chain. The market demand for IBS is important, as the adoption will depend on willingness of the clients to spend to get premium product offered by IBS. The demand should also be linked with macro economic demand. The industry will need to penetrate and focus on the certain market sector (high-end, high-quality or affordable, low cost or only on public building where the contract and design repetitive). Advanced planning and project management is the heartbeat of IBS, from its inception as a project, design phase, supply chain, delivery coordination, construction and installation on-site – all must be planned intelligently. Training and awareness at all levels of decision making are highly important to facilitate change from conventional to IBS. The industry perceives that the government should play extensive role in establishing training programs through continuous professional development (CPD) and conducting continuing awareness program. The policy and regulatory issues are core to the uptake of IBS; changes and incentives will further encourage uptake. Table 2 summarises the critical success factors of IBS implementation in Malaysia.

Readiness of Organisation in IBS Adoption

Organizational readiness presents a measure to which an organization or business may be ready, prepared or willing to obtain benefits which arise from the economy (conventional and digital). In this context, an advanced state of organizational readiness is needed for businesses to expand domestically and internationally; to compete readily in the global open market and optimize the adoption of IBS. It is therefore imperative that organizations align their business strategies with IBS strategies. Readiness within the organisation is built from the rubrics between people, process and technology (Siemieniuch and Sinclair, 2004; Alshawi, 2007). In this respect, built environment organisations are no different from any other sector specific organisation. These three elements are highly interrelated; for example, developing competence in one element must be accompanied by improvement in the others for the organisation to succeed. Another example is 'process improvement', as this is one of the many competence issues that an organisation needs to develop in order to achieve IBS capability. By default, this element also requires people with the necessary skills and knowledge to implement process improvements – the mandate of which also embodies the creation of an environment that is conducive to, and can facilitate these proposed changes. This organisational context also embraces such levers as motivation, empowerment and the management of change. Thus, it is important to encourage and support the integration between people and process through a flexible and advanced technology infrastructure (Lou and Goulding, 2010).

People can be considered as core drivers of a business. As a collective force, they can add value to organisational IBS readiness. However, they must be in place to understand organisational processes (implement change where necessary), and use technology to accelerate their efforts. People must however be led – the importance of leadership stems from its role in providing a clear vision of the future, communicating the vision, being prepared to provide sufficient commitments to the overall efforts and bearing the ability to motivate people rather than directly guiding them (Hammer and Stanton, 1995). It is therefore essential to obtain optimal human capital and skills, which in turn, is represented through the selecting right people for the right jobs, which could improve innovation and creativity (de Jong and Den Hartog; 2007). Business process is a core indicator of how an organisation functions. As a general rule: the more effective the business processes are, the more efficient the

organisation tends to work. Mulcahy (1990) observes, to be successful, a construction organisation must have clear objectives recognising the markets it wishes to address, services it wishes to provide, risk it may undertake, the structure it will use, the environment it will operate within, the controls it will put in place, and the returns it wishes to achieve. The focus on technology is a major factor behind raising organisational IBS readiness; specifically: managing, operating, standardising, maintaining, forecasting and investing technology is therefore seen as a core function (Lou and Goulding, 2010). The management of ICT is therefore critical in order to ensure that new technologies and emergent economies are successfully leveraged.

Strategic outlook

The outlook for IBS implementation in Malaysia is immensely positive. Nonetheless, it was identified that the change of the conventional practice to IBS is an onerous task for the stakeholders despite the vast business opportunities. The main barriers for the industry to embrace IBS are rarely purely technical in origin. They are more related to the organizational soft issues and strategy, which underpin the capability of organizations to successfully implement IBS method. The IBS adoption requires fundamental structural change to the industry. IBS change the way people in the building industry work, both in term of the process and product. To further promote the adoption of IBS, it is identified that the readiness of the organization to embrace this change is critical. The readiness of organizations looks into the process, people and technology factors, which makes the core of IBS adoption. In the model, the level of readiness (both the current and target) should be clear and indicative of the organization's situation in terms of measurable attributes and maturity levels. By identifying the current and the required organization statuses, the readiness gap can be determined and the route of transformation progress becomes visible. Progress can be accomplished when organizations move through the levels in sequential order.

The integration of IBS components or modules into the building requires various parties and supply chain to cooperate closely. This requires very careful definition and management of interfaces between contractors and suppliers and a good communication channel. It has been suggested that by implementing integrated approach in design and construction, the fragmentation gaps could be

minimised. IBS is seen as an expensive, risky and difficult solution for contractors who normally aim for a higher marginal profit by cutting operation costs. The transformation of company from the conventional system to IBS requires a tremendous focus on CSFs to achieve the transformation goal. More research should be done in the area of change management, Business Process Re-engineering (BPR), Benchmarking, occupational psychology and identifying the success factor for IBS that can help contractors and other adopters to move to IBS.

However, the incentives for IBS are not sufficient. IBS adoption requires more pull and push factors from the government. Due to the small profit margin, the change from conventional to IBS was not feasible, unless, more attractive incentive systems and benefits, which can lure the conventionalist to IBS, are in place. As we live in open and liberal market place, the decision to use IBS is commonly based on dollar and cent judgment. Any promotion efforts should be focused on the demand side of IBS as well as develop capacity in the supply side. The payment mechanism for IBS should be re-reviewed – the adopters require safer and more reliable payment mechanism and contracts. The construction industry should benchmark with other industry particularly in manufacturing and automotive to understand the mechanism that works for IBS construction.

The manufacturers of IBS component require business continuity in producing component and ethos of continues improvement in product development. As such, a soft loan for manufacturers should be created or promoted in collaboration with other government agencies. Supply Chain Management (SCM) and partnering concept has not been fully understood by the industry. Currently, the cooperation between contractors, manufacturers and suppliers is weak in many cases. Improving the procurement system and supply chain is the key to achieving IBS success for contracting companies. Partnering with suppliers and sub-contractors from the earliest project stages is vital to ensure efficient and timely delivery of components and services.

IBS is not well accepted by the construction companies because of the failure to adequately deal with risks in the IBS projects. In order to reduce risks, a careful risk strategy is very important. Sub-contracting and establishment of IBS subsidiaries can reduce some risk based on contractual 'risk-transfer' solution. In addition, the contractor can attempt to own the prefabrication technology by devising a special relationship with one or more prefabrication subcontractor, such as project-based

joint venture, vertical integration or even internalisation. IBS should not be seen as a threat to traditional methods. The failure of IBS to penetrate the market is due to a misconception that it will eventually replace the traditional sector, while it actually should work closely in tandem to promote best practice in construction. The sharing of best practice between the two approaches is essential for the continued successful development of both construction sectors.

The IBS research's trajectory should be move from technical research to tackling soft issues. Researches need to look more on people aspect i.e. how professional which has been trained in conventional construction to use IBS. IBS adopters should be able to manage and engage with multi-disciplinary organisations in IBS, thus, the project management capability and human capacity programs become more and more important in the future. IBS also requires fresh thinking and 'blue ocean' strategy to capture new demand, create new market space and offer customers a leap in value. The blue ocean is an analogy to describe the wider, deeper potential of market space that is not yet explored.

Sustainability is the way forward both in research and policy. The introduction of Malaysian Green Building Index (GBI) developed by Association of Consulting Engineers Malaysia (ACEM) and Pertubuhan Arkitek Malaysia (PAM) aims to promote sustainability in the built environment and raise awareness among the industry players about environment issues. Building will be awarded GBI Malaysia's rating score based on six key criteria including energy efficiency, indoor environment quality, sustainable site planning, material and resources, water efficiency and innovation. GBI provides a fresh challenge for the construction industry to practice sustainable development and at the same time providing highest quality of affordable building. IBS can be a potential solution to this. IBS promoters should see this as an ample opportunity to promote a greater use of IBS. Most importantly, more research should be conducted in this area to create new innovation in IBS and link IBS with sustainability issue that could possible helping the industry to successfully addressing GBI.

Conclusion

The introduction of the Industrialised Building Systems (IBS) in Malaysia is paving the way for a radical change in the Malaysian construction industry – embedded within the Construction Industry

Master Plan (CIMP), championed by the Construction Industry Development Board (CIDB) and promoted by the Government of Malaysia, it is hoped that IBS could bring about practice and thinking transformation in the industry. Since its introduction in 2003, the uptake of IBS has received a lukewarm response from the industry, accounting for only 10% of the completed projects 2006. Clients, contractors, manufacturers and suppliers are shying away the idea due to the lack of interest and expertise, economics of scale and lack of incentive, among many other barriers.

Since 2008, the outlook for IBS implementation in Malaysia is bright considering that the government is already mandating all public-sector projects must attain no less than 70% IBS content under the Treasury Circular SPP 07/2008. This policy was created to build a momentum and to establish demand for IBS components, thus bringing the cost down. For the private sector, there is an exemption to the Malaysian construction levy (CIDB levy - 0.125% of the total cost of the project according to Article 520) on contractors that have used IBS in 50% of the building components in residential buildings. Further in the 10th Malaysia Plan for 2011 to 2015 is expected to grow 3.7% a year compared to GDP growth of 6% a year (CIDB, 2010). The construction industry is also catalyst in supporting the implementation of Malaysian new Economic Transformation Programme (ETP) in the creation of infrastructure and buildings. As in September 2010, there is 129 IBS manufacture in Malaysia production 305 types of IBS products, about 217 IBS consultant and 678 contractors registered with the Malaysian Construction Industry Development Board (CIDB, 2010).

Nonetheless, there are much more work to be done to support the transformation of the industry to IBS and solve the implementation barriers as mentioned above. In addressing these issues, two major high-level strategic workshops were conducted to identify the major issues on the implementation of IBS from the perspective of manufacturers, contractors and suppliers. The attendees agree that the low rate of adoption is mainly contributed to the poor understanding on IBS by professional and designers in the industry – the fragmented industry does not help either. So far, the reluctance is due to the cost and no 'quick wins' to encourage involvement. This will spark the issues of economics of scale factor and the wider demand of IBS products and designs. The integration process will engulf new work processes, innovative design and engineering possibilities, flexible project planning, logistics and supply chain management. The Government will need to further provide more incentives for organisation to uptake

IBS. In the second workshop, a set of critical success factors (CSFs) was identified, this include issues relating to partnering and contract; training and education; business strategy; finance; advanced planning and project management; roles and In-house capability; marketing; skills and competency; availability of continues market; information technology; identification of market sector; and policy and regulation. To further promote the adoption of IBS, it is identified that the readiness of the organization to embrace this change is critical. The readiness of organizations looks into the process, people and technology factors, which makes the core of IBS adoption.

Strategically, the industry will need to embrace change (for the better) and integrate work processes, which includes all sectors in the industry – client, contractors, suppliers and manufacturers – but the fragmented industry does not help. The available critical success factors for IBS implementation will assist new organisations to adopt IBS. In the long run, organisations will want to access their state of readiness to adopt IBS – achieving readiness within the context of built environment requires organizations to radically re-think their people-process-technology issues in order to embrace change. There is a strong argument that the industry needs to adopt a 'measured approach' in order to help them be IBS-ready. This readiness could be augmented through some form of a practical framework, which would allow them to measure organizational readiness position across the people-process-technology triumvirate for the adoption of IBS.

References

Alshawi, A. (2007). *Rethinking IT in Construction and Engineering: Organisational Readiness*, Taylor and Francis, UK.

Bernama (2009). *Shift to IBS Technology, Abdullah Urges Contractors*, Bernama News, 19 March 2009, Agency Berita Nasional (BERNAMA) <http://www.bernama.com/bernama/v5/newsindex.php?id=397382> (Mar. 22, 2009).

Bullen, C.V. and Rockhart, J.F. (1981). "A primer on critical success factors (Working Paper No. 69)", Massachusetts Institute of Technology, Sloan School of Management, Centre for Information Systems Research, Cambridge, Massachusetts, USA.

CIDB (2003). *IBS Roadmap 2003-2010*, Construction Industry Development Board (CIDB) Malaysia, Kuala Lumpur, Malaysia.

CIDB (2003a). *IBS Survey 2003*, Construction Industry Development Board (CIDB) Malaysia, Kuala Lumpur, Malaysia.

CIDB (2005). *IBS Survey 2005*, Construction Industry Development Board (CIDB) Malaysia, Kuala Lumpur, Malaysia.

CIDB (2006). *Construction Industry Master Plan 2006-2015 (CIMP)*. Construction Industry Development Board (CIDB) Malaysia, Kuala Lumpur, Malaysia.

CIDB (2007). *Malaysian Construction Outlook 2007*, Business Development Division, Construction Industry Development Board (CIDB) Malaysia, Kuala Lumpur, Malaysia.

CIDB (2008). *Malaysian Construction Outlook 2008*, Business Development Division, Construction Industry Development Board (CIDB) Malaysia, Kuala Lumpur, Malaysia.

CREAM (2010a). *Proceedings of the 1st CIDB/CREAM IBS Roundtable Workshop (IRW01),* Construction Research Institute Malaysia (CREAM). Kuala Lumpur, Malaysia.

CIDB (2010b). *Industrialised Building System (IBS) Info*, Issue 3/2010, IBS Centre Malaysia Publication, Construction Industry Development Board Malaysia (CIDB), Kuala Lumpur, Malaysia.

de Jong, J.P.J and Den Hartog, D.N. (2007). "How leaders influence employees' innovative behaviour", *European Journal of Innovation Management*, 10(1). 41 – 64.

DOSH (2008). *2008 Annual Report*, Department of Occupational Safety and Health, Ministry of Human Resources (DOSH), Kuala Lumpur, Malaysia.

DTI (2004). *Modern methods of construction in Germany – playing the off-site rule*, In Venables, T. and Courtney, R. (Eds.). Global Watch Mission Report, Department of Trade and Industry (DTI). London, UK.

EPU (2006). *The Ninth Malaysia Plan*, The Economic Planning Unit (EPU). Prime Minister's Department, Putrajaya, Malaysia <http://www.epu.gov.my/html/themes/epu/html/rm9/html/english.htm> (Nov. 27, 2010).

Gibb, A.G.F. (2001). *Pre-assembly in Construction: A review of recent and current industry and research initiatives on pre-assembly in construction*, Construction Research & Innovation Strategy Panel CRISP Consultancy Commission 00/19, London, United Kingdom.

Hamid, Z.A., Kamar, K.A.M., Zain, M.Z.M., Ghani, M.K. and Rahim, A.H.A. (2008) "Industrialised Building System (IBS) in Malaysia: The Current State and R&D Initiatives", *Malaysian Construction Research Journal (MCRJ)*. 2 (1), 1 – 11.

Hammer, M. and Stanton, S. (1995). *The Re-engineering Revolution*, Harper Collins, New York, USA.

Kamar, K.A.M., Alshawi, M. and Hamid, Z.A. (2009). "Barriers to Industrialised Building System (IBS): The Case of Malaysia", *BuHu 9th International Postgraduate Research Conference (IPGRC)*. Alshawi, M., Ahmed, V., Egbu, C. and Sutrisna, M. (Eds). Salford, United Kingdom, 471 – 484.

Khalfan, M. M. A. McDermott, P. Li, X. Arif, M. and Kashyap, M. (2008). "Developing Innovative Procurement Strategies to Integrate Suppliers and Manufacturers within Construction Industry", *International Journal of Value Chain Management (IJVCM)*, 2(3), 358 – 370.

Lou, E.C.W. and Goulding, J.S. (2010). "The pervasiveness of e-readiness in the global built environment arena", *Journal of Systems and Information Technology*, 12(3). 180 – 195.

MPC (2009). *2008 Annual Report*, Malaysian Productivity Corporation (MPC), Kuala Lumpur, Malaysia.

Mulcahy, J.F. (1990). "Management of the Building Firm", *Proceedings CIB 90, Joint Symposium on Building Economics and Construction Management*, Sydney, Australia, 11 – 21.

Rockhart, J.F. and Crescenzi, A.D. (1984). “Engaging top management in information technology”, *Sloan Management Review*, 25(4). 3-16.

Sarja, A. (1998). *Open & Industrialised Building*, CIB Research Studies and Documentation, The International Council for Building, E&FN Spon.

Siemieniuch, C.E. and Sinclair M.A. (2004). “A framework for organisational readiness for knowledge management”, *International Journal of Operations and Production Management*, 24(1). 79 – 98.

Table 1 : The 7 strategic thrusts within the Construction Industry Master Plan (CIMP) for Malaysia (CIDB, 2006).

Thrust	Description
Strategic Thrust 1	Integrate the construction industry value chain to enhance productivity and efficiency
Strategic Thrust 2	Strengthen the construction industry image
Strategic Thrust 3	Strive for the highest standards of quality, occupational safety and health, and environmental practices
Strategic Thrust 4	Develop human resource capabilities and capacities in the construction industry
Strategic Thrust 5	Innovate through research and development and adopt new construction methods
Strategic Thrust 6	Leverage on information and communication technology in the construction industry
Strategic Thrust 7	Benefit from globalisation including the export of construction products and services

Table 2: Critical success factors of IBS implementation in Malaysia.

Critical Success Factor (CSF)
Partnering and Contract
Training and Education
Business Strategy
Finance
Advanced Planning and Project Management
Roles and In-house capability
Marketing
Skills and Competency
Availability of Continues Market
Information Technology (IT) as enabling factors
Identification of market sector
Policy and Regulation

Figure
Common.Links.ClickHereToDownload

Figure 1 : IBS implementation barriers by the industry and adopters.